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GENERAL ENTERPRISE ARCHITECTURE CONCEPTS AND THE BENEFITS FOR AN ORGANIZATION

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Abstract: Managers need to understand the relationships among information architectures and infrastructures and strategic planning within their organizations. This will enable them to make the best use of technology to support the organization’s efforts to accomplish its mission in the most efficient and effective manner.

This paper examines the intent and significance of policies in regard with Information Technology Architectures. The concept of an Enterprise Architecture (EA) is introduced with a focus on using such architecture as an enabler to accomplishing the mission of the organization.

The benefits and costs of an EA are also discussed. Among the topics covered are gaining executive support for an EA, overcoming impediments to developing and implementing an EA and understanding the role of the Chief Information Officer (CIO) in the development and implementation of the architecture. The paper emphasizes the importance of an EA in aligning the infrastructure with the strategic direction of the organization.

Key words: Enterprise Architecture, Chief Information Officer, Technical Reference Model, Standard Profile.

1. Introduction

Managers need to understand the relationships among information architectures and infrastructures and strategic planning within their organizations. This will enable them to make the best use of technology to support the organization’s efforts to accomplish its mission in the most efficient and effective manner.

This article discusses the history of Information Technology (IT) and how systems have evolved over time to the current condition in which most enterprises need Enterprise Architecture (EA) to understand the relationships of all of the pieces. Because of the complexities of both the business operations and the technology supporting them, it is difficult to clearly understand how everything fits together without an EA. It would be like trying to build or maintain any complex structure without the benefit of a blueprint that shows the interdependencies.

Let us imagine building a large construction without having an architecture. One such effort actually did take place - it is called “The Winchester House”[1]. Does this sound familiar? Does this sound a little like the way we acquire and build information systems? Many systems have evolved over the years with very little direction and control by the owners, managers, and users of the systems. An EA provides the structure and the discipline to correct this unacceptable situation.

The aim of this paper is to allow the potential readers to 1) derive the management responsibilities associated with administering the laws relative to the development and implementation of agency architectures and infrastructures, 2) explain the significance of

an EA in aligning the infrastructure with the strategic direction of the organization and 3) recognize the barriers to successful implementation of an EA and determine ways to overcome them.

We will discuss the ambiguity in terminology and provide some basic definitions of a few key terms as they are used in this article. You will become familiar with pertinent laws, policies, and directives that specifically address EAs. We will take a look at the role of the CIO and the challenges that a CIO must face in order to meet her/his responsibilities with regard to an EA. Finally we will begin to identify the benefits that an EA brings to an enterprise as well as reflect on the difficulties that exist in managing an EA.

2. Definition of Terms

One of the difficulties in discussing an EA is the lack of consistency in terminology. This is symptomatic of the fact that this is a very immature discipline. Often the same words are used with different meanings or different words are used to have the same meaning. In this respect, here are some confused terms: **Framework**, **Model**, **Infrastructure** and **Architecture** which are often used interchangeably. However they have very specific meanings.

- **Framework:** As its name implies, the framework is actually a way to frame the construct. It provides structure in the way that a template or form provides a format for providing information or data. There are no standard frameworks for EA's in existence today. However there are several initiatives to begin the tedious and difficult task of developing the frameworks.
- **Model:** A representation of the information. For example a model airplane represents an airplane. It is not the actual airplane but a representation of one. With EA's these models are not currently as well defined or widely accepted as this example because, in terms of maturity, this discipline is still in its infancy. However, there are some models that are gaining wider acceptance.
- **Infrastructure:** Everything that is required to support the "business". In this article, "business" is used to mean the reason that an enterprise exists. The infrastructure includes the hardware, software, telecommunications, security, standards, training, people, facilities or whatever is necessary to "get the job done".

So then what exactly is an architecture? An architecture is a slightly more abstract concept. According to [2] architecture is defined as "*A structure of components and their relationships, which evolve over time and include: principles and guidelines*". The definition is slightly refined as "*the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution*" [3].

An architecture is the basic construct for describing a concept or an idea. This can be better explained through the use of an analogy. Let's analyze the architecture of telling time. If one understands the basic architecture of 24 hours in a day, and 60 minutes in an hour, 60 seconds in a minute, then time can be expressed and understood using many different technologies (analog, digital, etc.).

However to a small child who does not yet understand this architecture, noting that the big hand is on the 10 and the small hand on the 2 would not have meaning. An architecture identifies and describes the relationships. The components of the architecture of time are the hours, minutes, seconds, days, weeks, months, or whatever we define them to be. If we changed those relationships and based time on something other than the solar

calendar, we could still tell the time but the context would change accordingly. For example if we used the lunar calendar all references to a day would double and we would redefine a year and so forth.

3. Laws, Policies and Directives

The Clinger-Cohen Act requires “*A complete Information Technology Architecture (ITA) that provides an integrated framework for: evolving or maintaining existing IT, acquiring new IT and achieving the agency's strategic and IRM goals*” [4]. With the passing of the Clinger-Cohen Act of 1996, US Federal Departments were required to use an Information Technology Architecture (ITA) in order to ensure alignment of the technology with the needs of the business.

Note that the Clinger-Cohen Act required the use of an Information Technology Architecture (ITA) and it specified what the ITA must insure. However, the Act did not define an ITA and there was certainly a wide range of speculation on what exactly would be required in order to be compliant with this law.

In 1997, the US Office of Management and Budget (OMB) put out a memo that provided some very loose guidance about what must be included in the ITA in order to meet the intent of the Clinger-Cohen Act. OMB Guidance on Enterprise Architectures stated that “*Agencies must document and submit their initial enterprise architecture (EA) to OMB and submit updates when significant changes to the EA occur*” [5]. This guidance was later revised and incorporated into OMB Circular A-130 [6].

Again, note that the Clinger-Cohen Act referred to the Information Technology Architecture rather than the enterprise architecture so naturally the focus was placed on technology by most of the organization. However the intent of the law was to improve enterprise wide performance by integrating technology most effectively with the optimized processes. This really requires an enterprise architecture that includes the explicit descriptions of the processes and information flows as well as the supporting applications, data and technology. For this reason, the more appropriate term used today is enterprise architecture rather than information technology architecture.

The OMB memo requires documenting the relationships but it does not specify the manner in which this is done. It does not constrain the media to paper or text only. Therefore any media may be used and graphics may be more descriptive and precise than text only. Other media than paper may lend itself better to keeping the information current and readily available to those who need it in a timely way.

4. Enterprise Architecture: Definition and Components

4.1. Enterprise Architecture: A Definition

The term Enterprise Architecture is defined as “*The explicit description and documentation of the current and desired relationships among business and management process and information technology*” [6].

Why would you care about the current or desired relationships? Is the desired relationship the same as an end state? Imagine yourself in a large shopping mall trying to find the movie theatre. You look at the directory and find the theater. Good, so let's proceed to the theatre. But don't you need one more important piece of information? How can you get there from here unless you know where you are? You always find the red dot that says “you are here” on the mall directory to give you a point of reference. Only then

can you plan your trip to get to where you want to go. It is the same with the enterprise architecture. You must know and understand the current as well as the target relationships so that you may formulate a plan for getting there.

One question that you might be asking about now is what is meant by the enterprise. The enterprise is whatever you define it to be. It provides a specific purpose or mission. For instance it could be the Ministry of Defense with the mission of providing national defense or it could be one of the services within defense such as the Army, Air Force or Navy.

It need not be tied directly to an organization. Ideally each enterprise architecture at the localized level would be consistent with the architecture for the larger enterprise in which it must fit or interact. This requires that the architects understand the larger architectures and ensure the proper level of congruence. For example, if you were the architect for a suite of rooms in a large building, you would need to ensure that your architecture was consistent with the rest of the building and the building architect would need to ensure consistency with the neighborhood buildings, city and county.

4.2. Enterprise Architecture Components

There are five basic components that make up the enterprise architecture [6]:

1. Business Processes;
2. Information Flows and Relationships;
3. Applications;
4. Data Descriptions;
5. Technology Infrastructure.

The manner in which these are presented is not specified. The memo simply states that these components must be included. The hierarchy of the components is not prescribed except for the business process component which determines what information is needed. Think of these as the basic categories of ingredients of the EA.

The *business processes* describe what it is that the enterprise does. The *information flows and relationships* describe what information is needed to perform the business processes. The *applications, data* and *technology* describe the applications, data, and technology needed to provide the appropriate flow of information to support the business processes. The enterprise architecture must also include a Technical Reference Model and a Standards Profile.

4.3. Technical Reference Model (TRM)

So what is this technical reference model? According to OMB A-130, TRM “*Identifies and describes the information services used throughout the agency*” [6].

A better way to understand this notion is to make an analogy and view the TRM as a restaurant menu. The menu categorizes food groups and the TRM categorizes information services. For example if I hired a restaurant to cater a banquet, I would likely meet with the caterer and decide what types of food that I wanted at the banquet. I might include a five course meal, with appetizers, soup or salad, main entrée, dessert, and beverage. I might instead include only appetizers and beverages. I might have only finger food. I could have cold cuts. Whatever I decide becomes my reference model.

The TRM for information systems identifies information services such as data interchange or human computer interfaces. You may wish to browse through a couple of examples of TRM’s, such as the Federal Enterprise Architecture Technical Reference

Model [7] and the TRM for the Department of Defense [8] to get a feel for what type of information is included.

4.4. Standards Profile (SP)

The final component identified in the OMB memo as being part of the EA is the standards profile. Reverting back to the restaurant menu analogy, if the TRM is the categories of food groups, the standards profile (SP) is the list of food options within each group. For example if for my banquet I decided that I would include finger food, the standards profile might include a vegetable tray, chips and dip etc. The EA standards profile defines a set of standards that supports the services articulated in the TRM. It establishes the minimum criteria needed to specify the technology that supports the business function.

An example of the standards profile is the Department of Defense's enterprise wide standards profile, called the Joint Technical Architecture [9]. Does the use of a standards profile encourage/discourage open systems? Let's think about this. At one end of the spectrum, a completely open system could accommodate any technological solution to a problem. On the opposite end of the spectrum a propriety system would identify a specific technological solution to the problem. By identifying standards we are constraining the total possible solutions to a subset that conform to the specified standard.

The question then is does this encourage or discourage open systems? In theory one might say it discourages open systems because it eliminates any solution that is not covered by the standard. However, in reality it should encourage open systems because it is not feasible from an economic or efficiency standpoint to accommodate all possible solutions or designs that might satisfy a given requirement. However by providing a standard, there may be many specific designs that comply with the standard. Such standardization is part of our daily lives and the standard must change as the need arises. Thus the standards profile is not static and it is constantly changing as the needs change and the industry and market demands.

5. Role of the Chief Information Officer (CIO)

Now that we have discussed the enterprise architecture, let's take a look at the role of the CIO regarding the EA. The Clinger-Cohen Act, in sections Sec. 5125 b2 and 3, is very specific in assigning the responsibility of developing, implementing and maintaining the enterprise architecture to the CIO. Regarding EA, the CIO should [4]:

- Develop, maintain, and facilitate the implementation of a sound and integrated IT architecture for the executive agency;
- Promote effective and efficient design and operation of all major information resources management processes;
- Promote improvements to work processes.

This is indeed a tall order. What skills the CIOs would require? Should the CIO be business savvy (should the CIO understand the business of the organization)? Should the CIO be technically savvy (should the CIO understand technology and be versed in the state of the art capabilities)? Ideally the CIO would be business and technically knowledgeable.

In fact to be most effective some would say that the CIO should be business savvy first. In reality the CIO will probably be stronger in either the business or technical area but not both. How might this deficiency be supplemented? You could staff the CIO office with people who are competent in each area. If the CIO is very technically capable but lacks a

good breadth of understanding of the business of the organization, he could hire a deputy who fills this void, someone who is very connected with the business side of the organization.

6. Problems Addressed by Architecture

Now that we have discussed what an EA consists of and who is responsible for managing it, let's look at why you would want to bother with it at all. What value does it add and what problems is it addressing?

Each of us could probably identify many uses for an EA. Based on my research I have focused on three problems that I believe an EA can help to solve. Each is addressed in further detail next. Enterprise Architecture can help solving the following problems into an organization [10]:

- Lack of guidance for decision-making;
- Inability to manage change;
- Inability to communicate the organization's goals.

As technology increases in complexity and as managers struggle to be more and more responsive conflicting requirements to meet the demands of the business, better and timelier information is needed to make the best decisions in a responsive time frame. Change today is the norm rather than the exception. Flexibility to respond effectively to the changes is critical for survival. Finally and in my opinion most importantly, the EA provides a mechanism to improve communications. It becomes quite a challenge to communicate across domains and from various levels and perspectives. The EA can help to focus the point of a discussion by ensuring that everyone is "on the same page".

6.1. Lack of Guidance for Decision-making

Without an architecture the organization will not have:

1. An enterprise-wide conceptual framework for planning I/S development;
2. A way to measure existing applications against upgrades or changes;
3. A framework for I/S to be developed and implemented cost effectively;
4. Standards to measure conformance of COTS in make or buy decisions;
5. A way to prioritize projects within a specified time-frame.

How can an EA help with decision making? Architecture provides the framework for ensuring that enterprise-wide goals, objectives, and policies are accurately reflected in decision-making related to building, acquiring or changing information systems. In your organization is there always enough funding to resource every requirement? If not how are priorities set? How does the senior management ensure that they have current and relevant information upon which to base strategic and tactical decisions? Could a well-documented EA provide the information? You may say that it is too difficult to develop the EA. Why not just research and acquire the information as it is needed? This would certainly appear to be a viable alternative to having an EA or is it?

In a small enterprise with a relatively simple operation in terms of interdependencies I would agree. However in a large, complex operation, acquiring the needed decision making information can be very labor intensive. Many individuals may have a need for this information on a regular basis, necessitating each individually seeking the information repeatedly as required. A single individual or group of individuals would only have knowledge about some subset of information systems at any point in time. However it was much too large and complex for anyone to fully understand the entire

enterprise information system and be able to explain the relationships of each application and data description to the business process that it supported.

Therefore decisions are made based on limited knowledge or decisions are delayed until the information could be gathered. Neither approach is without considerable risk. Basing the decision on the wrong or incomplete information could have disastrous results but a delay when action is needed can also have many adverse affects. Decisions are often made by a consensus of several key managers each bringing different perspectives and concerns for consideration in the process. Without an EA each view is usually understood only by the person making that point. However with the EA, each view is presented and modeled so that it is possible to better appreciate the various issues for consideration that should be factored into the decision.

6.2. *Inability to Manage Change*

In the absence of an architecture an enterprise:

1. Cannot effectively deal with change;
2. May not be able to understand the impact of change;
3. May not accurately reflect the status of information systems before and after change.

A key issue in dealing with the high rate of change in today's complex information environment is understanding the effect of any given change in the context of the enterprise as a whole, rather than in terms of its components. Each person (organization) could understand the impact of the change from a very narrow view only. This made it very difficult for the decision makers to get a complete and accurate assessment of the impact of the change as a whole.

What they have at best is a sense of the various concerns expressed from a specific view of the change being proposed. The sum of those views does not necessarily equate to the impact on the entire organization. A documented EA that could enable improved communications of the impacts of these changes from the organization's perspective.

6.3. *Inability to Communicate the Organization's Goals*

In the absence of an architecture an organization:

1. Will develop systems independently and possibly duplicate systems;
2. Will not adequately communicate about the linkages between their information systems;
3. Will miss opportunities to share data;
4. Will have different definition and different naming of same data or will have the same naming of different data;
5. Will not have systems that satisfy organizational requirements.

Lack of an architecture leads to information systems with no clear picture of the interrelationships among the systems. In systems engineering, one learns early that optimizing the performance of each individual system component, will not ultimately result in optimum overall system performance. The optimal system performance is the result of a prudent mix of optimization of each component. In order to achieve the right mix, the experts of each subsystem must be able to communicate internally with the other experts.

However the benefit of communications extends even beyond the internal gains recognized. Often the EA is useful in communicating externally to those who need to interact with the enterprise. For example, you could communicate a funding shortfall

through the use of the EA and thus be able to attain the necessary funds because you will clearly show the direct linkage of expended funds for technology and enhancements to mission capabilities.

7. Impediments to Achieving a Solid Enterprise Architecture

Now that we have discussed briefly what an EA is and what problems it is intended to solve, let's take a look at some of the reasons why it is difficult to accomplish. Here are some of the obstacles that must be overcome [11]:

- Awareness/Recognition/Acceptance by top management;
- Commitment of resources to EA planning;
- Unfavorable corporate culture;
- Political differences regarding responsibilities for EA planning;
- Lack of credibility of planning leaders;
- Inexperience with EA planning;
- Resource shortages and large applications backlog.

The most important condition for success is the support of top management. This is basically an educational process. If top management is not supporting the EA, in all likelihood they do not recognize its benefits. You must convince them through briefings, examples, external consultants, conferences, journal articles or whatever works best with your particular situation. Along with support comes the commitment of resources.

When managers are referring to the EA in terms of "you" and "yours" versus "us" and "our" they are not committing. Organizational culture can also be an impediment. The culture may alienate the people who must be participants in the development of the EA.

The effort to develop an EA may be perceived as "solving world hunger" and the EA planners may lack credibility. This is evidenced through statements like "that's not how it's done here" or "you are living in an ideal world and this is reality". There are some additional obstacles in order to develop a viable Enterprise Architecture:

- Finding the "best" methodology;
- Educating information systems personnel in new technologies;
- Uncertain rate of return;
- Expecting immediate results;
- Fear of loss data control/ownership;
- Benefits difficult to measure
- Inaccessible or uncooperative users and delegation.

There are always long debates over the best methodology. The solution is just pick one and get on with it, because all methodologies can work in a given situation. Some may be better than others but spending too much time trying to decide on the best one is usually non-productive. The EA may be viewed by some as a threat. This may be evidenced by statements like, "if it isn't broke, don't fix it".

Many of the obstacles discussed here are managerial in nature versus technical. These are very difficult to overcome but there are successes to learn from. It is important to note is that the EA probably will not be perfect the first time, because speed should take precedence over the depth of the analysis. That is not to say that we should sacrifice completeness and quality of the EA.

We should try to put out the best we can in the shortest time possible. It will not have all of the detailed information needed nor will it be inclusive of every scenario within

the enterprise. However it will get things started. The details that may have been overlooked or not ready for inclusion at first can be added to the subsequent versions.

In conclusion, when trying to advocate and eventually develop and implement an Enterprise Architecture, we have to take into consideration the following three most important issues. How would EA help to improve government service to citizens and businesses and how could EA help you do your work better or easier. Why is it difficult to gain support from the organization in developing and implementing Enterprise Architecture and how can resistance be overcome. And last but not least, think about your personal answers to those questions: should the CIO be business savvy first and technically knowledgeable second or the reverse (and why); can a technical expert be an effective architect without having any knowledge of the business; can a business expert be an effective architect without any knowledge of the technical considerations.

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